



Light Vector mesons from dAu in PHENIX

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status

- Scope:
 - dAu phi to ee (dndy,T) min bias - prelim
 - dAu phi to KK (dndy, T) min bias- prelim
 - Au-Au phi to KK (dndy, T, mass, width) centrality - final
- Data slides “almost final” (sys errors)
 - Question: Can I send data points for dAu (ee, KK) to Patricia?
- Explanation slides – sketchy
- Comments(?) about
 - Changes to Au-Au since QM 2003
 - Phi to Ee in qm2003

QCD and the vacuum

- The QCD lagrangian (I.e. nature) obeys chiral symmetry (Why?? Is it true?)
- -> everything has mass=0
- Doesn't match the world
- What do we do? – invoke a complicated vacuum
 - The vacuum is not empty – it full of stuff (the “condensate”)
 - The interaction with the vacuum gives rise to mass
- Crazy.
- How do we see this?
- Heat up the vacuum – we boil it - and see if masses change
 - -> go to zero ultimately
- Chiral phase transition
- Any connection to deconfinement??



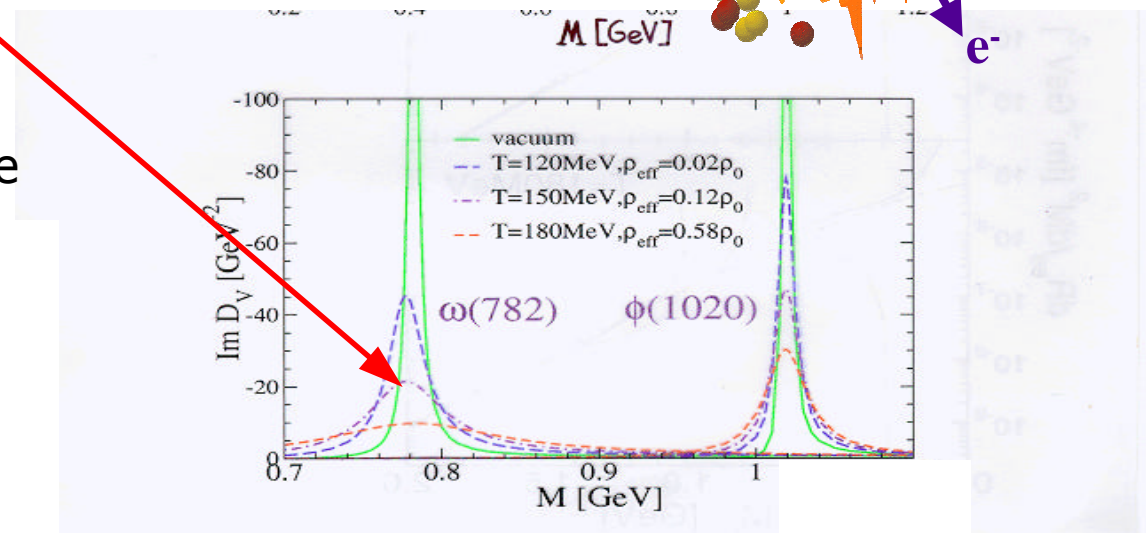
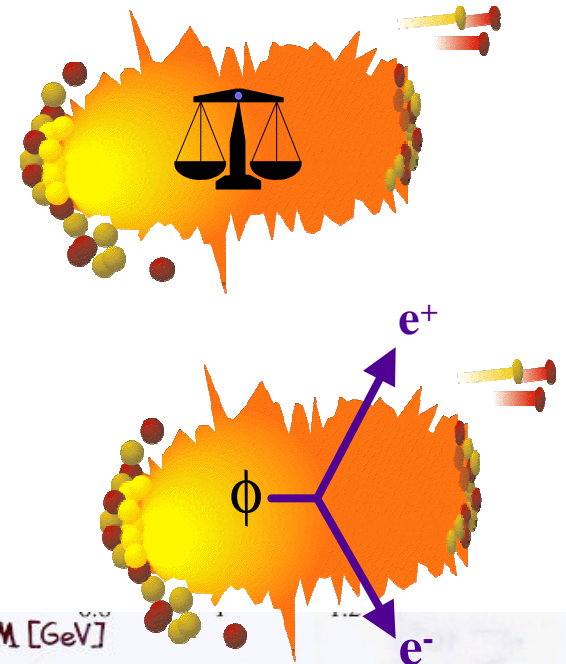
Vacuum
Nothingness

Looking for Chiral symmetry restoration

Vector Meson mass shifts in the dilepton channel

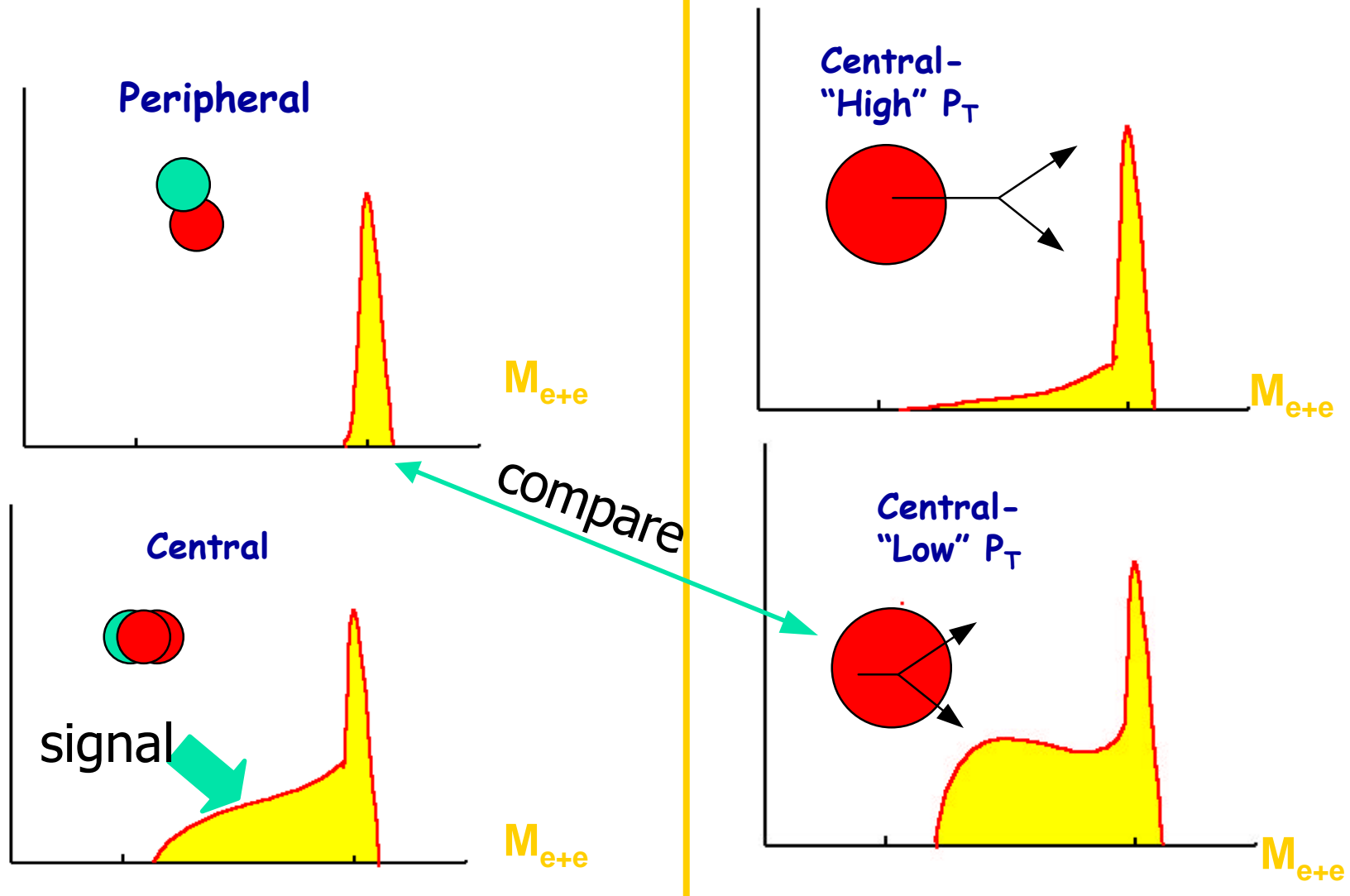
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- “Light” Vector mesons are ideal probes (r, w, f)
 - Like putting a scale to measure mass inside the fireball
 - Short lifetime \sim few fm/c
 - Decay inside hot fireball
- Electrons (and muons) are ideal messengers
 - Don’t interact strongly (e.g. neutrinos from the sun)
- e.g. In Medium ω
 - shows low mass tail -
 - With its good mass resolution PHENIX should be able to see this
 - R. Rapp (Nucl. Phys A661(1999) 238c



Experimental “Knobs”

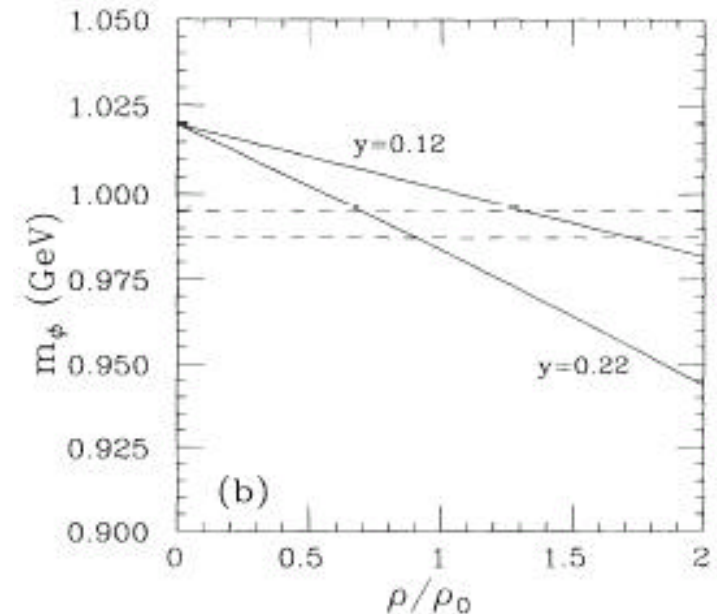
- Signal should increase with centrality
- Signal should be enhanced at low p_T



What do we look for?

- Chiral symmetry restored
 - High temperature vacuum – Au-Au Central
 - High baryon density
 - chiral symmetry is partially restored at even normal nuclear density.

- Look for
 - Mass shifts/broadening
 - Increase with centrality
 - Increase to low m_t
 - BR(kk/ee) change with centrality (Shuryak et al)



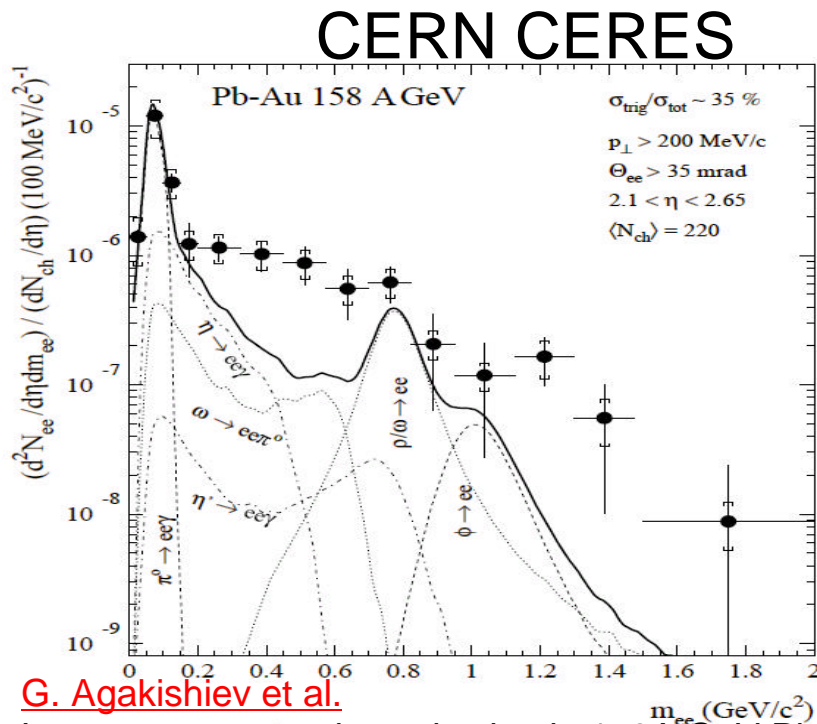
T.Hatsuda and S.Lee

QCD sum rules for vector mesons in the nuclear medium

(Phys.Rev.C46-1 1992)

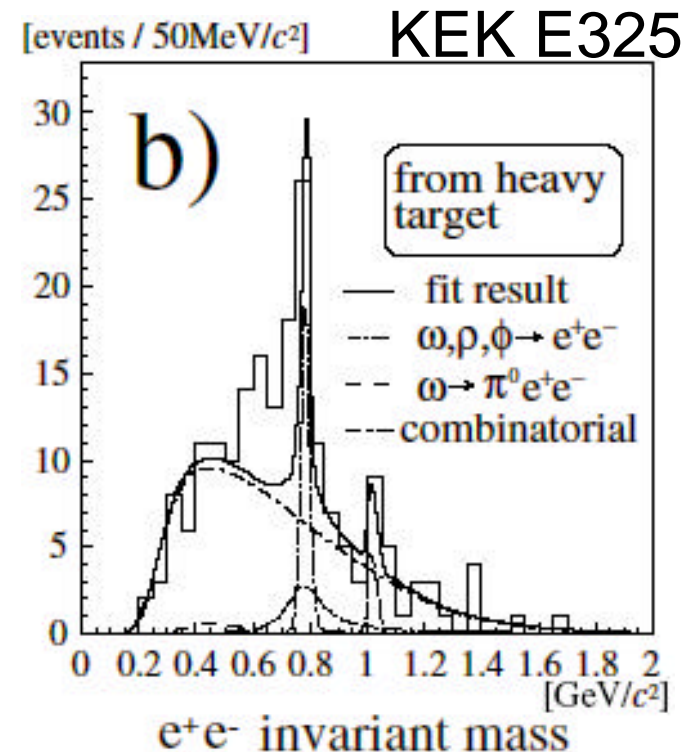
Has anyone seen this?

- Vector meson mass may be modified in dense matter even at densities \sim nuclear matter
- High T (a boiled vacuum)
- High baryon density



G. Agakishiev et al.

Low-mass e^+e^- pair production in 158A GeV Pb-Au collisions at the CERN SPS, its dependence on multiplicity and transverse Momentum ([Phys.Lett.B422:405-412,1998](#))



K.Ozawa et al.

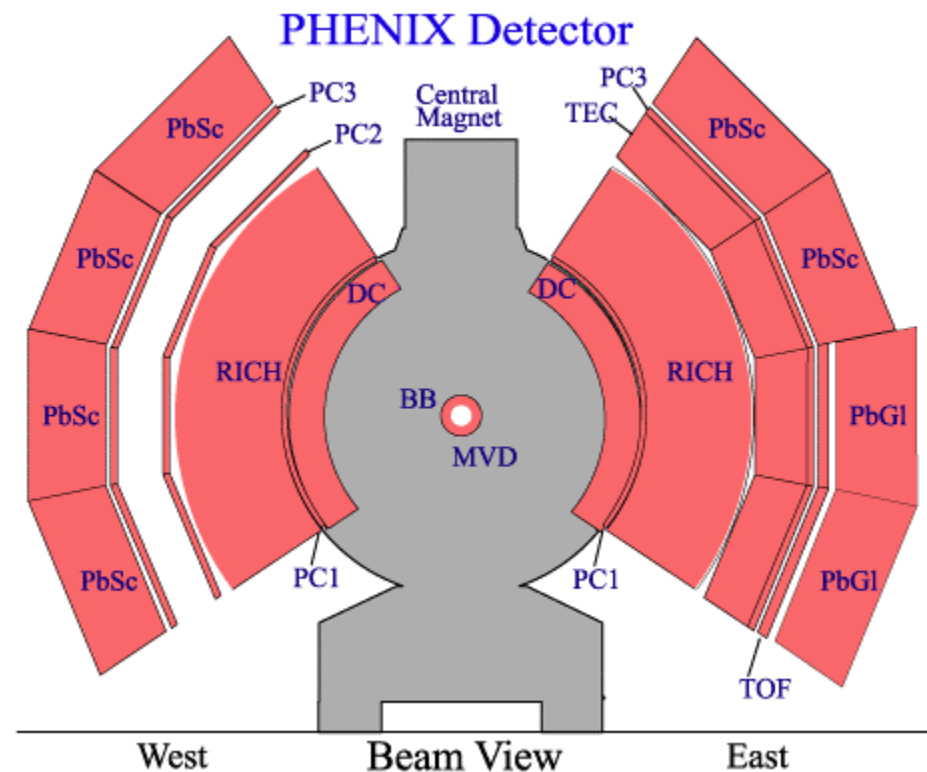
Observation of ρ/ω Meson Modification in Nuclear Matter ([Phys.Rev.Lett 86-22](#))

Outline

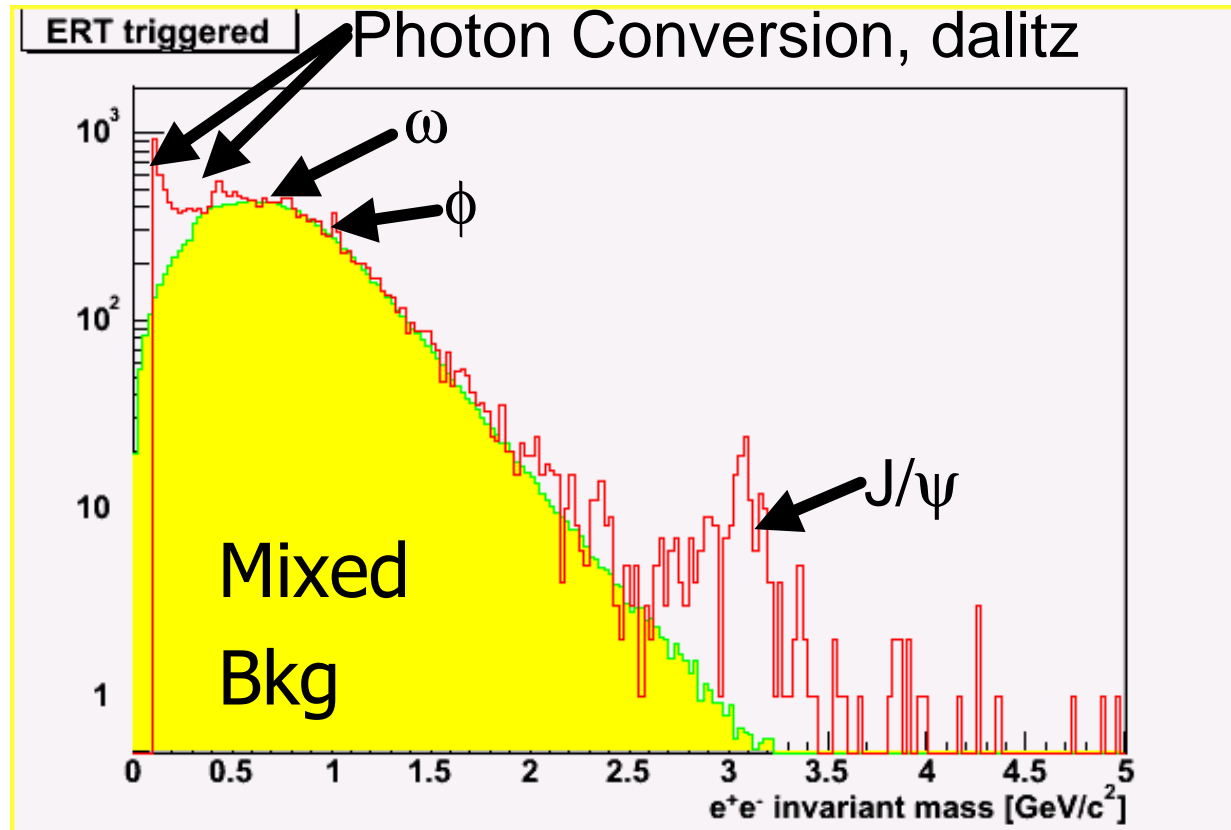
- dAu phi to ee (prelim)
- Dau phi to KK (prelim)
 - Compare BR (normal nuclear density)
- Au-Au phi to KK (final)
 - Mass shifts/broadening
 - Guess: cannot see this to hadronic decays (only see stuff which decays outside fireball)
- Centrality dependence of phi production/npart

PHENIX detector – designed for such measurements

- Designed for such measurement
 - Superb (and redundant) electron PID
 - RICH+EMCAL
 - PID (for kaons)
 - Via TOF to 2GeV
 - Via EMC to 1 GeV
 - Good momentum resolution
 - High rate capability
 - Triggering capability on electron
 - ERT
- Future
 - Upgrade w/ HBD
- Explain ERT
- Electron cuts



ee Invariant Mass Spectra 200 GeV dAu

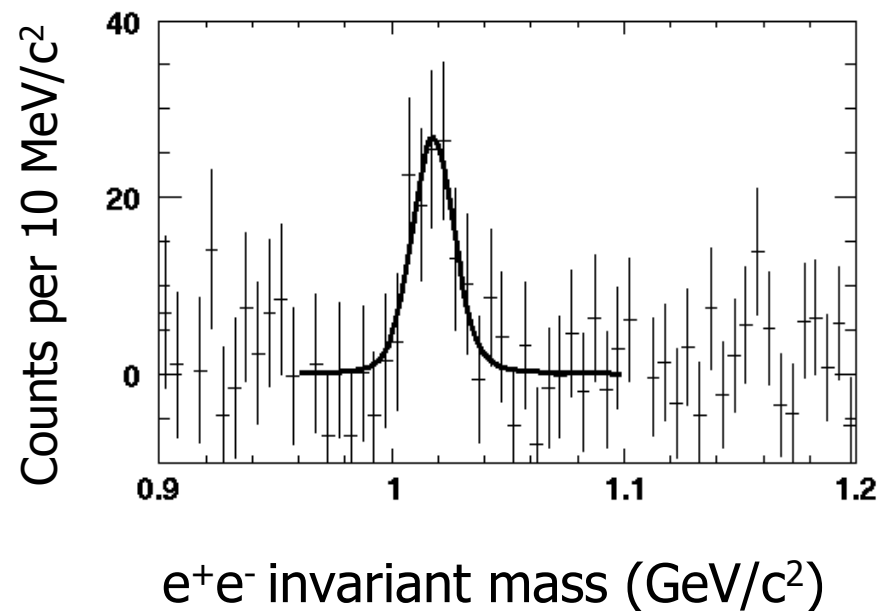
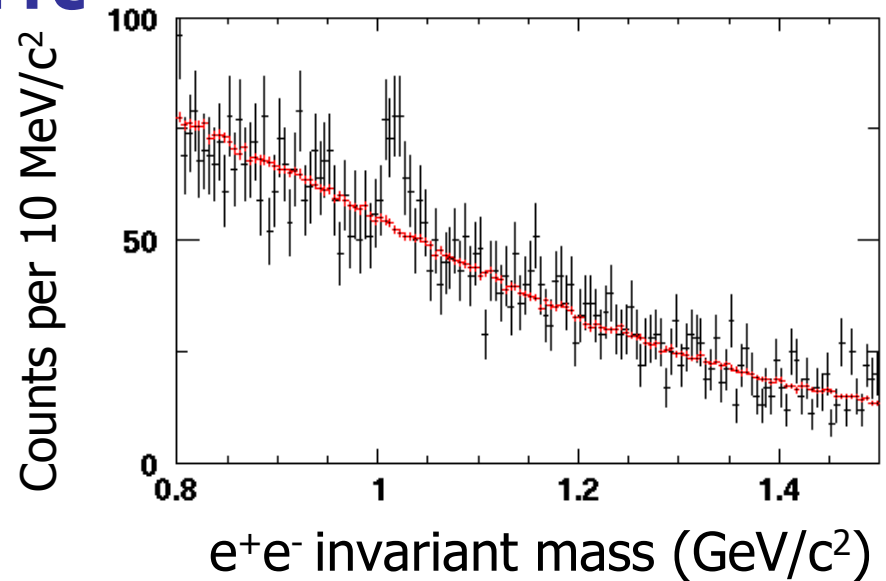


- Background estimated by event mixing with offline ERT-electron trigger emulation
- Use 500-600,1100-1200 MeV region for BG normalization of Opposite arm Events.
- Use 850-950,1100-1200 MeV region for BG normalization of Opposite arm Events.

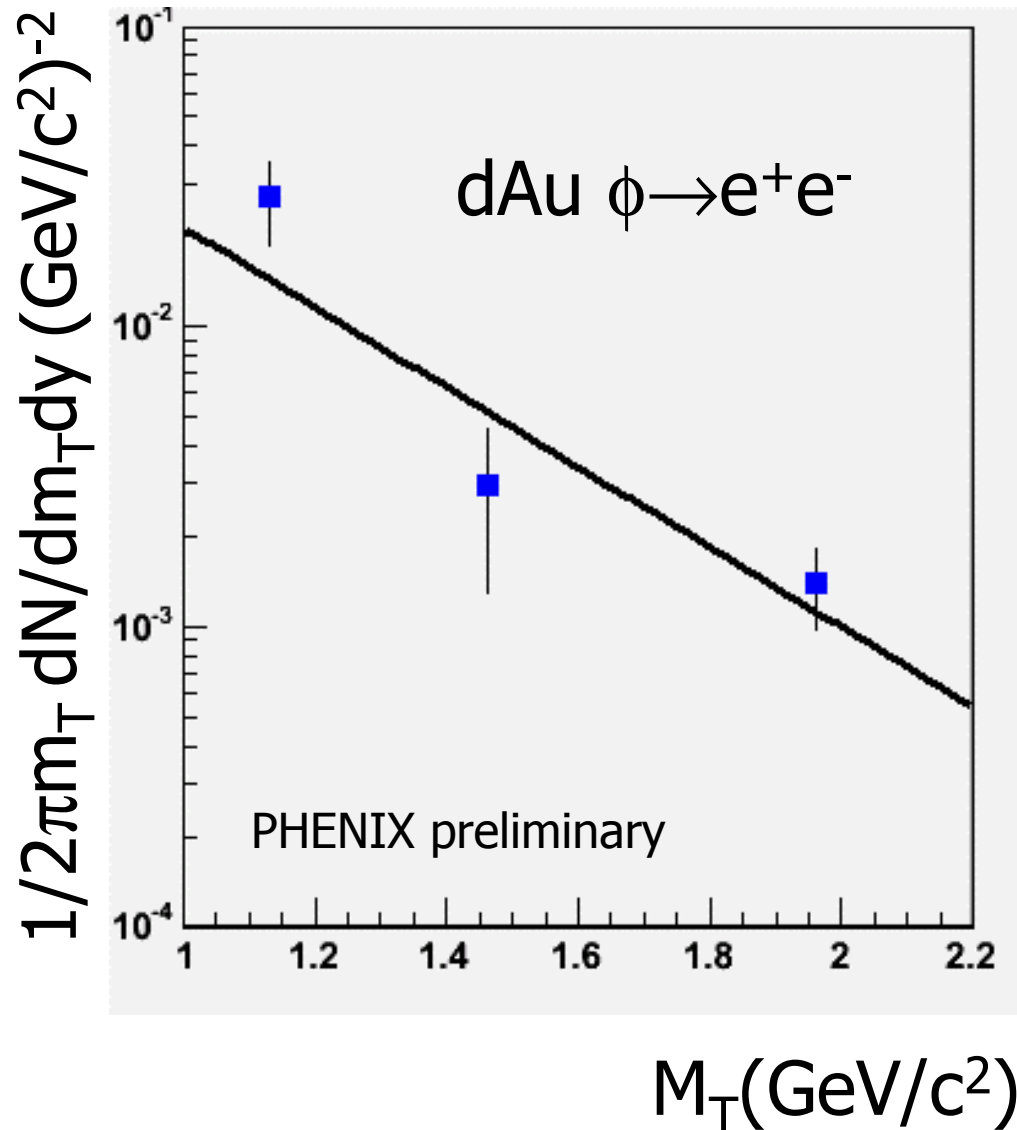
Advertise
yuji's poster

Min bias, all mt

- $M = 1.0177 \pm 0.0023$ GeV
- $\Gamma = 0.00446$ (fixed) GeV
- $\sigma_{\text{exp}} = 0.0081 \pm 0.0021$
- $\chi^2/\text{DOF} = 13.6/13$
- Fit is to relativistic B-W convoluted with gaussian
- Consistent with PDG



dN/dmt and yield



$$dN/dy = .056 \pm .015(\text{stat}) \pm 50\%(\text{syst})$$

$$T = 326 \pm 94(\text{stat}) \pm 53\%(\text{syst}) \text{ MeV}$$

PHENIX preliminary

- The major contributions to the systematic error are
 - normalization of the background and signal extraction and the way the variations affect T and hence dNdy
 - The run-by run variation from the ERT

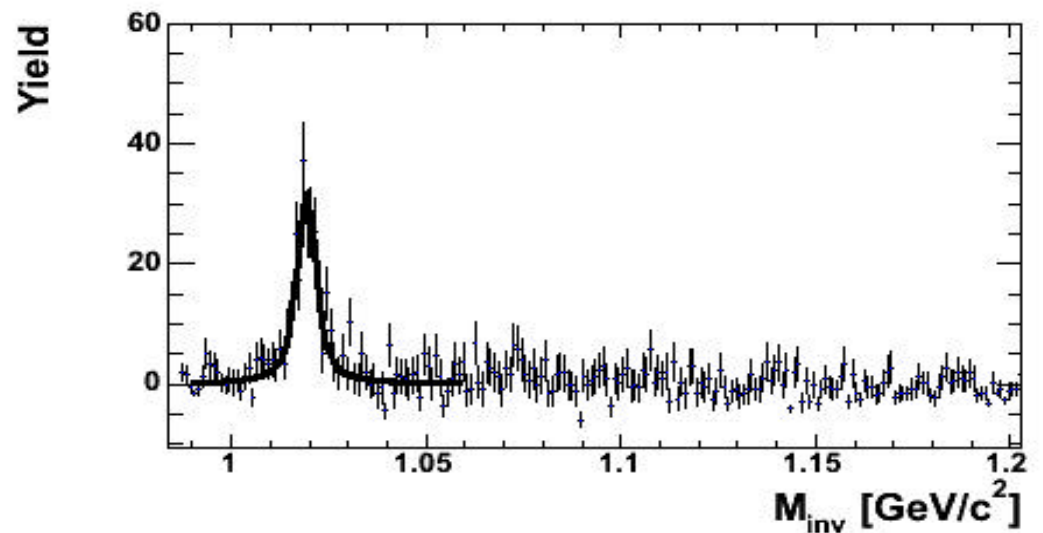
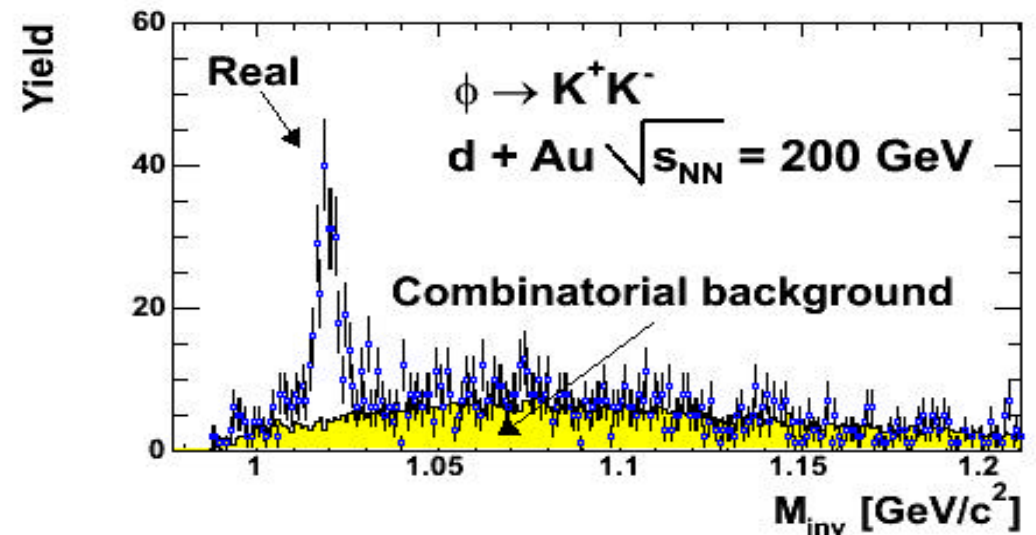
Dau – KK invariant mass

- PID in TOF only (smaller acceptance)
 - Higher pt
- $N_{evt} = 62 \text{ M}$
- Min. bias with
- $|bbcz| < 30 \text{ cm}$

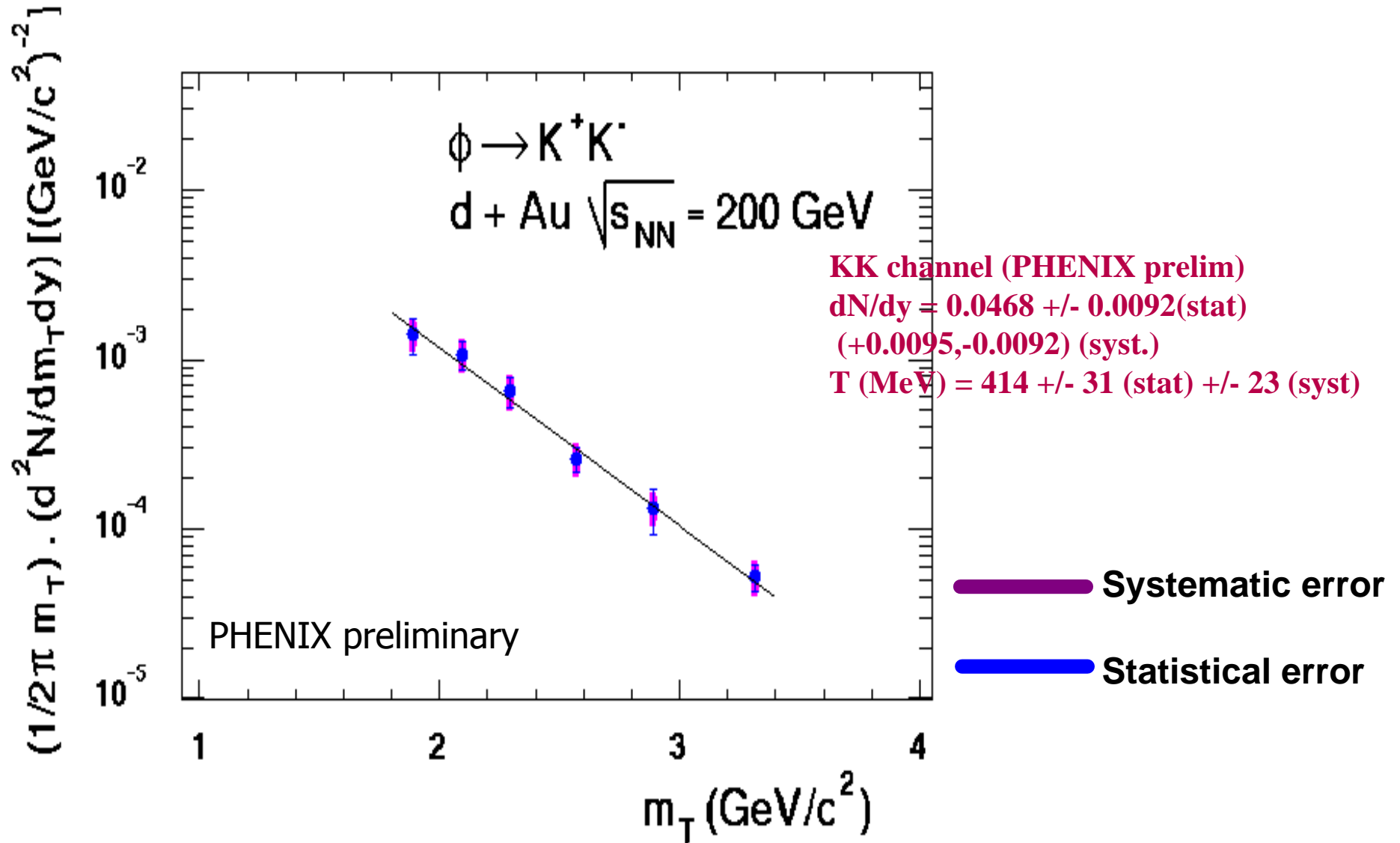
- $N_f = 207 \pm 16$
- $S/B = 1/0.16$
- $\langle m \rangle = 1.01927 \pm 0.000 \text{ GeV}/c^2$
- $G = 4.750 \pm 0.67 \text{ MeV}/c^2$

Advertise

Dipali's poster

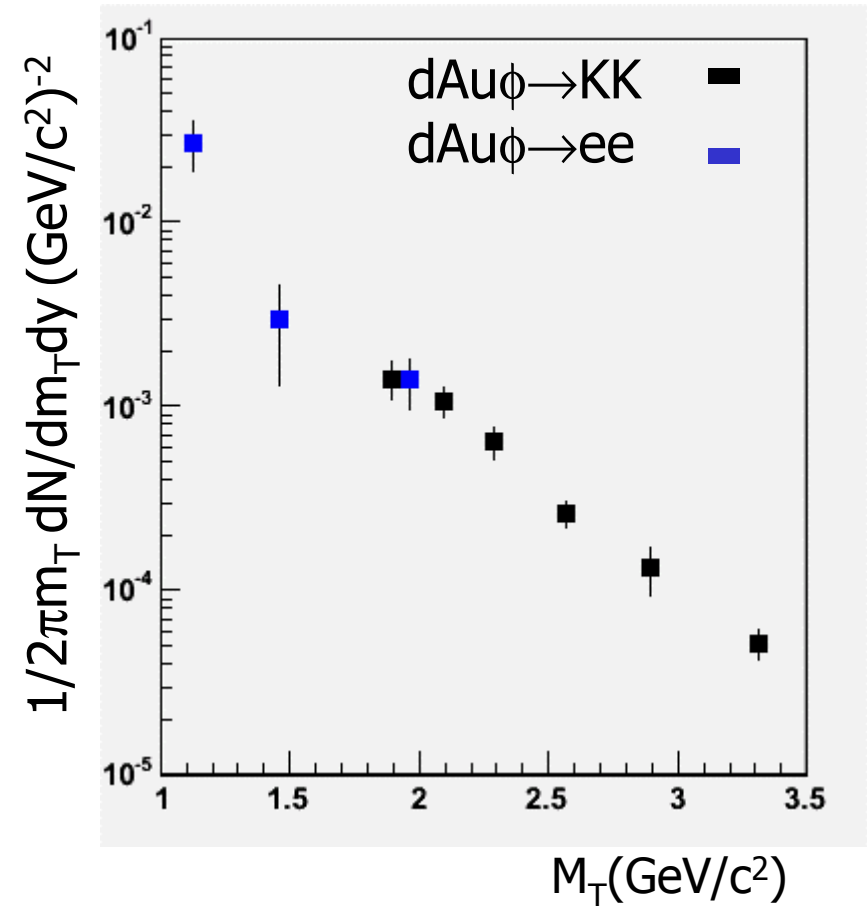


Minimum-bias m_T distribution of f



Consistency

- Consistency of ee and kk
- Fade into this



Comparison with KK results

KK channel

$dN/dy = 0.0468 \pm 0.0092(\text{stat})$

$(+0.0095, -0.0092) (\text{syst.})$

ee channel

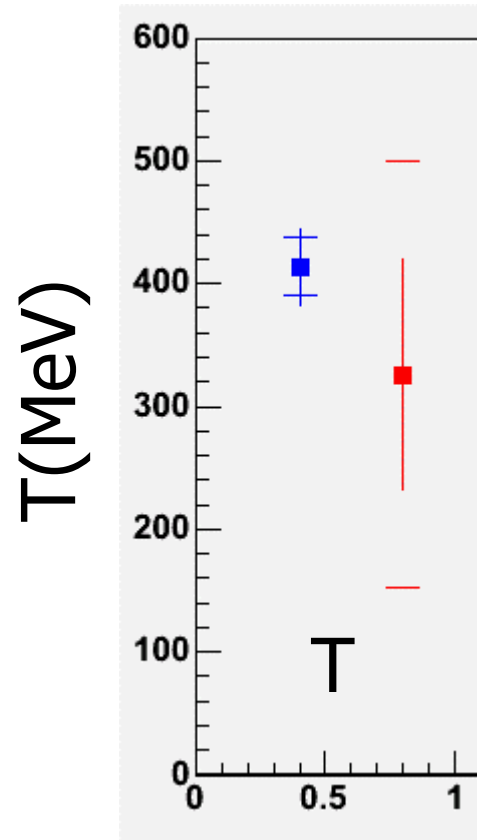
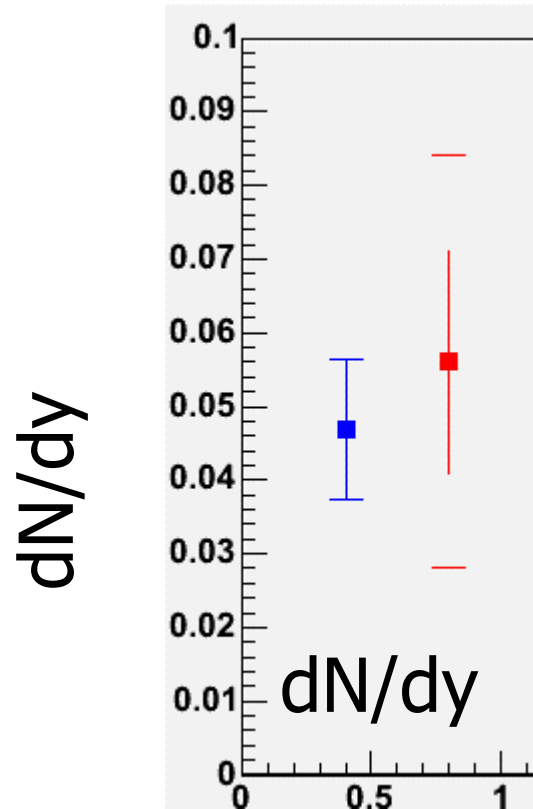
$dN/dy = 0.056 \pm 0.015(\text{stat}) \pm 50\%(\text{syst})$

KK channel

$T (\text{MeV}) = 414 \pm 31 (\text{stat}) \pm 23 (\text{syst})$

Ee channel

$T = 326 \pm 94(\text{stat}) \pm 53\%(\text{syst}) \text{ MeV}$

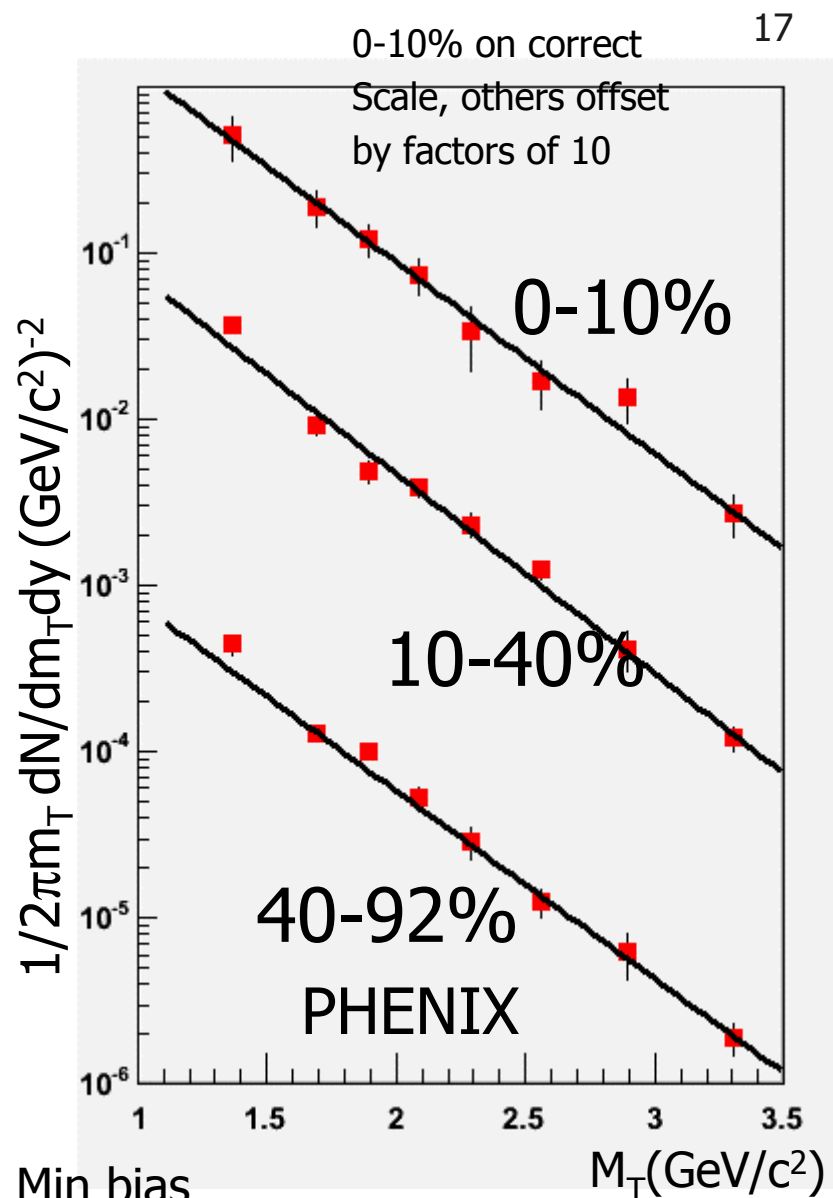
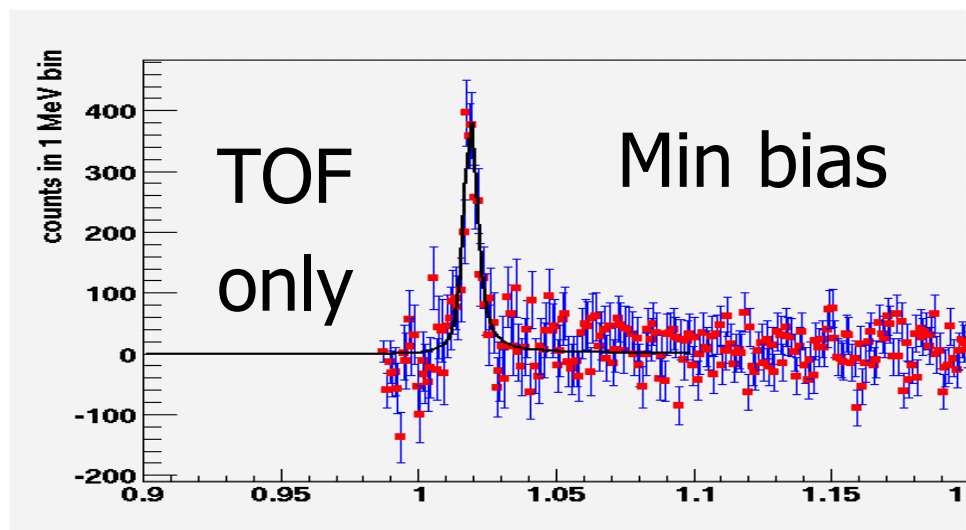
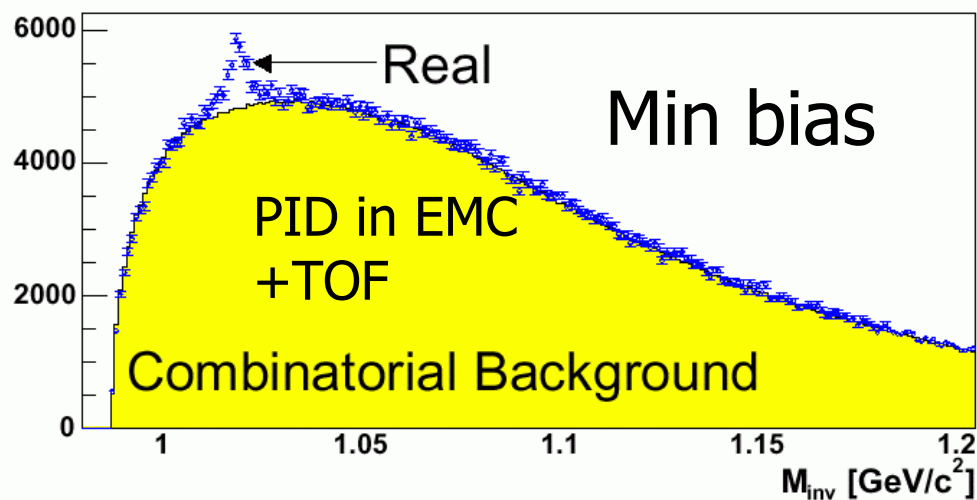


- Yields consistent with each other
- \rightarrow BR in normal ratio

PHENIX
preliminary

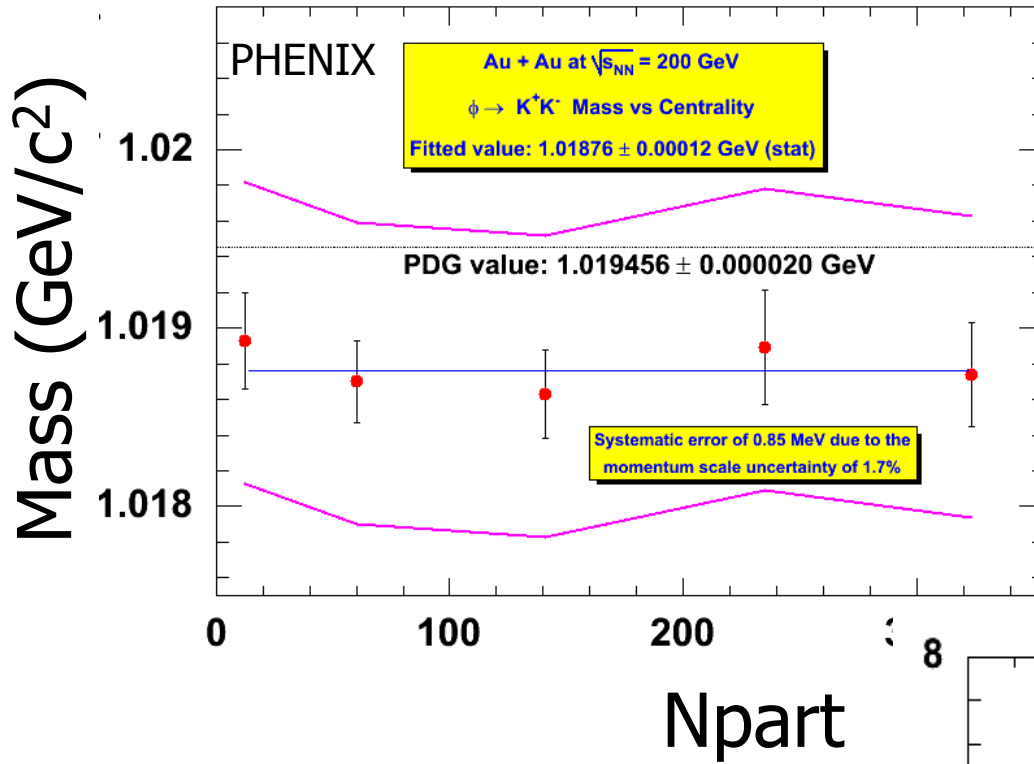
Au-Au phi to KK

charlie's poster



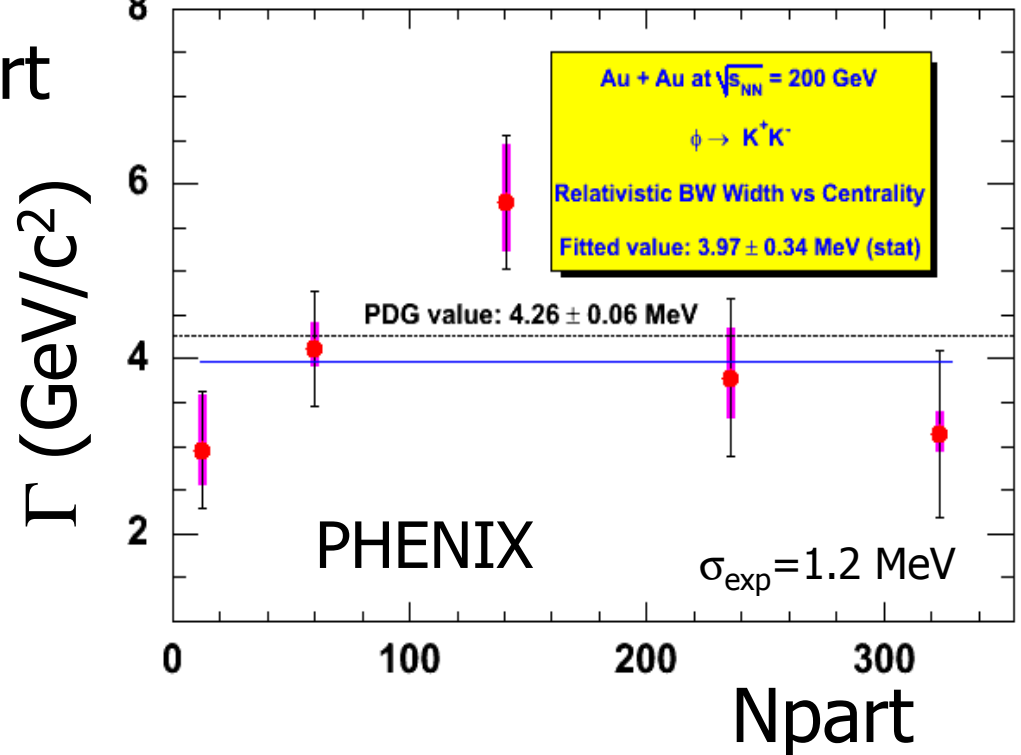
$$dN/dy = 1.34 \pm 0.09(\text{stat}) \pm 0.20(\text{syst})$$

$$T = 366 \pm 11(\text{stat}) \pm 18(\text{syst}) \text{ MeV}$$



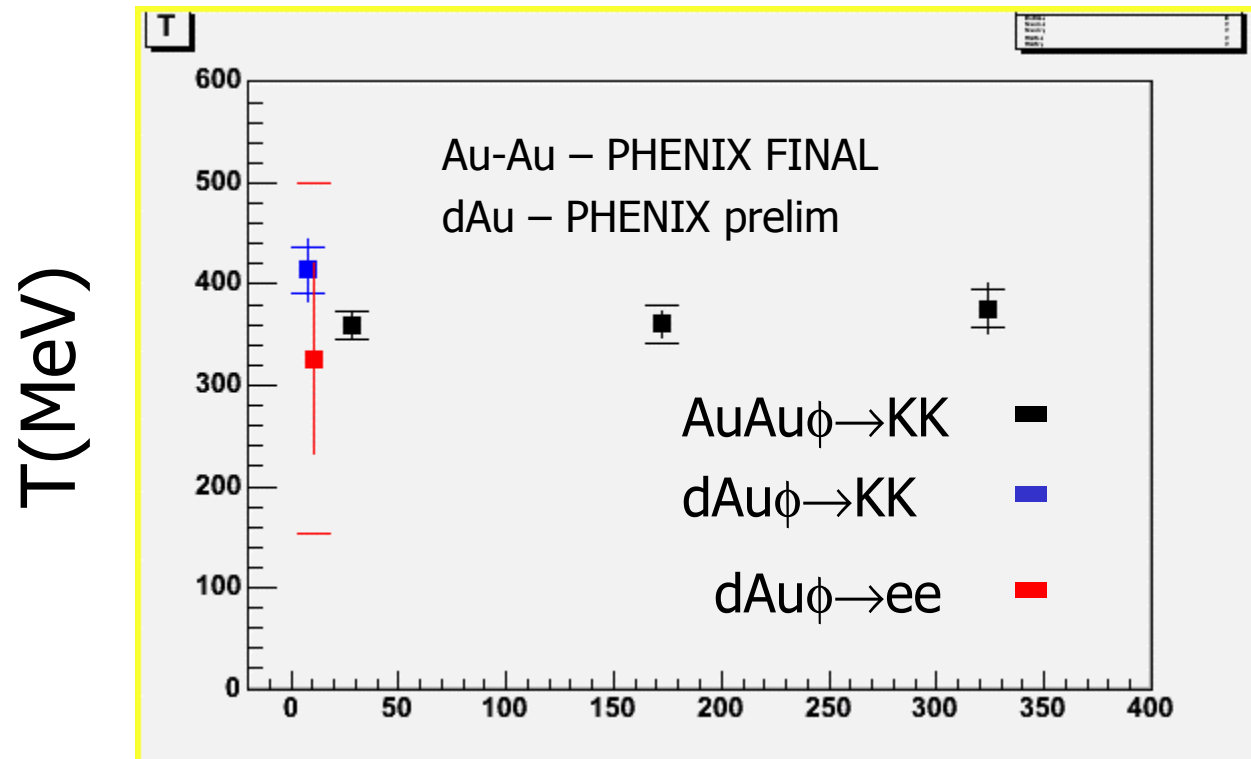
- Mass certainly independent of centrality- consistent with PDG
- Width consistent with PDG
 - Independent of centrality
- Not surprising
 - KK decays are outside of fireball

$\phi \rightarrow KK$ Au-Au 200 GeV
 Dependence of mass and width on centrality



On to more standard fare: Npart dependence of T

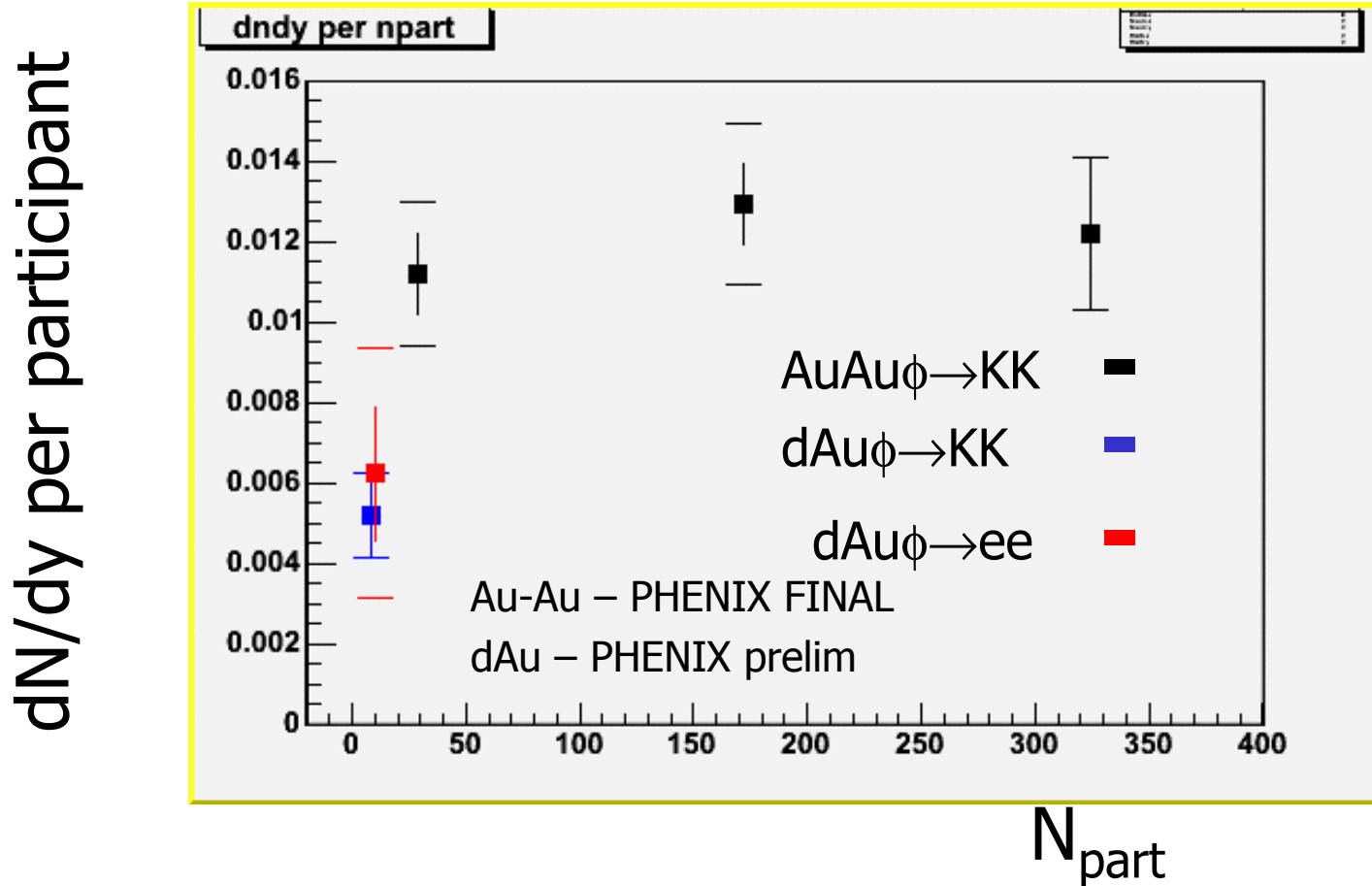
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T indep of centrality

N_{part}

dN/dy per n_{part} ($n_{part} \sim 9$)



dN/dy rises than seems to saturate

■ OK to patricia?

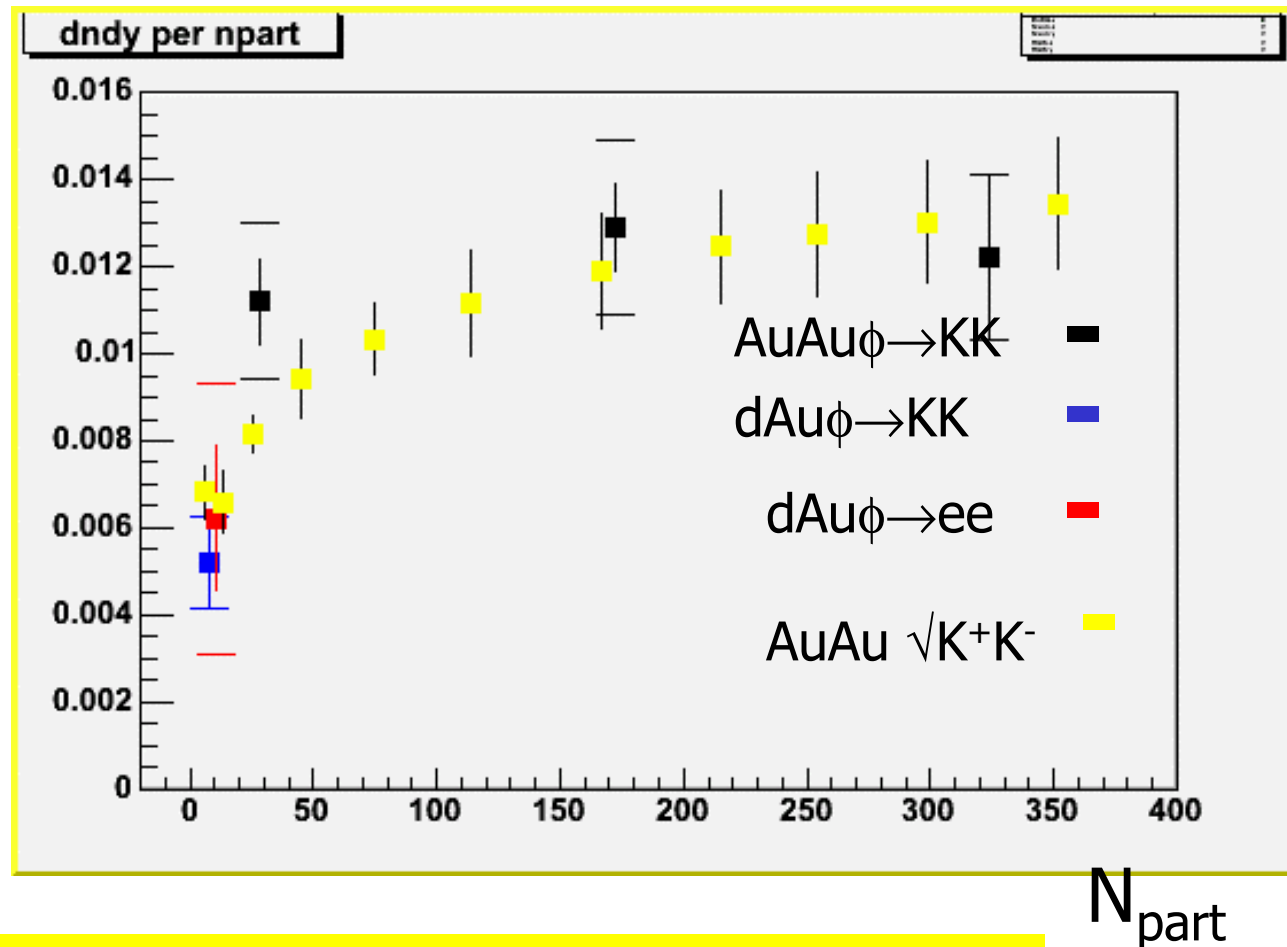
Add kaons

■ Fade to this

AuAu K – published (give ref)

Au-Au phi to kk– PHENIX FINAL

dAu – PHENIX prelim



dN/dy rises then seems to saturate as the kaons

■ OK to patricia?

Conclude

$dN/dy = .056 \pm .015(\text{stat}) \pm 50\%(\text{syst})$

$T = 326 \pm 94(\text{stat}) \pm 53\%(\text{syst}) \text{ MeV}$

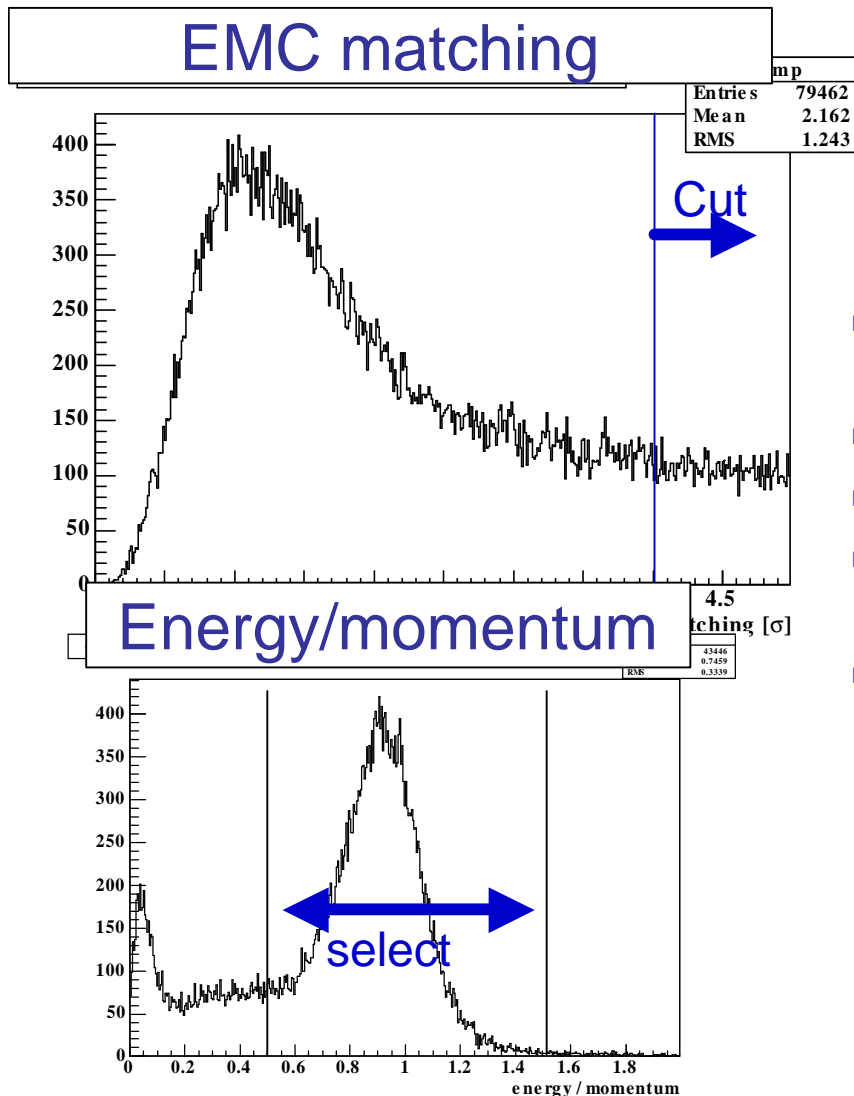
KK channel

$dN/dy = 0.0468 \pm 0.0092(\text{stat}) (+0.0095, -0.0092) (\text{syst.})$

$T (\text{MeV}) = 414 \pm 31 (\text{stat}) \pm 23 (\text{syst})$

- Summary:
 - A first measurement has been made of the phi to ee channel. Within error bars it agrees with the KK result.
 - For overall shapes in Au-Au phi to KK, mass and width stay consistent with PDG as a function of centrality
 - Strangeness Enhancement as a function of centrality, similar to kaons (look at lambda?)
- Note: early in the story of Imvm ee physics
 - Use rest of statistics
 - Better control of systematics
 - Upgrades/rates
 - Centrality dependence (dau-KK, ee?)
 - Omega
- run 4?
 - Phi flow
 - Ee – dependence on triggering etc

Electron identification



We used very loose cut in order to take more statistics, and to make estimation of eID easy

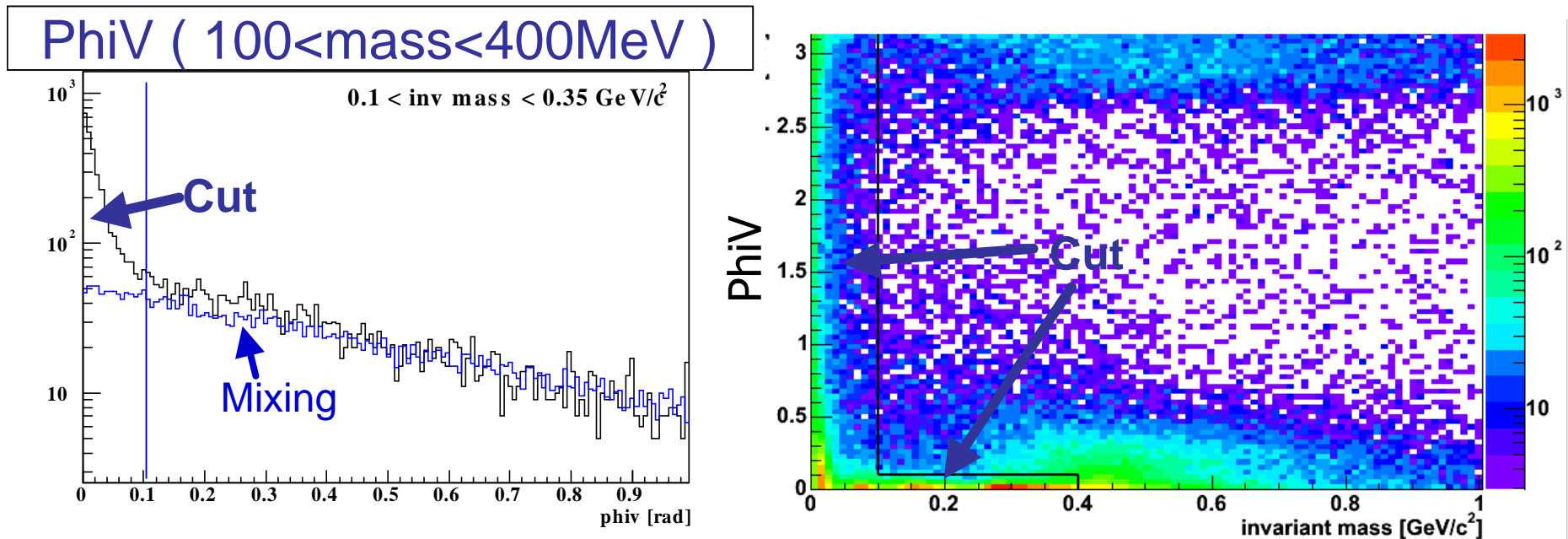
- EMC matching $< 4\sigma$
- $0.5 < E/p < 1.5$
- $n_0 \geq 2$
- Ghost track cut
 - kill worse matching track If $d_{zed} < 1$ & $d_{phi} < 0.1$
- RICH ring sharing cut
 - Kill one track if $dc_{zed} < 10$ & $dc_{phi} < 0.1$ randomly

$$\text{Matching} = \sqrt{dj^2 + dz^2}$$

Conversion Rejection by invariant mass and PhiV

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- e^+e^- pair from photon conversion has small phiv and small mass. we cut those pairs at low-background region
 - Kill all tracks if $\text{PhiV} < 0.1$ for $\text{mass} < 400 \text{ MeV}$
 - Kill all tracks if $\text{mass} < 100 \text{ MeV}$



ERT electron trigger & Event selection

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- Front-end electronics and data storage limit trigger and recording rate.
- Give priority for electron events to record.
 - ERT electron trigger by RICH & EMC online
- Analyzed 31M of ERT-electron Triggered Events.
 - Corresponds to 1.9G minimum bias (raw trigger)
 - 50% of total data taken during run3

